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Radiographic examination and outcome in consecutive feline trauma patients

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Introduction

Many domestic cats have free access to the outdoors and are frequently presented to veterinarians following trauma without a detailed history concerning the nature of the trauma. Conventional radiographic imaging is important to promptly diagnose the nature and extent of injuries in these patients, besides the physical examination. A majority of 65% of practicing veterinarians in Switzerland was found to use radiography as principle or only diagnostic imaging modality in 2001 (1).

A whole-body radiograph using a technique for chest radiographs, with the film cassette on the table, produces images of adequate quality in cats because of the relatively small size and more or less constant body width of the patient (2). This technique cannot be used in dogs because of the variation in width across their different body regions (3). Whole-body images in cats are of consequent diagnostic value, even though separate abdominal and thoracic views provide superior radiographic quality (2). Whole-body radiographs have been primarily performed on feline trauma patients at our hospital.

The purpose of this study was to investigate the incidence of injury in consecutive feline trauma patients based on whole-body radiographic findings, and compare the type of injury with their clinical outcome.

Material and methods

Whole-body radiographs of 100 consecutive feline trauma patients were examined. All patients were presented to our hospital between January 2001 and November 2002. Cases with left lateral and ventrodorsal whole-body radiographs incorporating the thoracic inlet and the entire pelvis were included.

The images were performed with the same radiographic equipment and technique. These were a Polydoros generator (Siemens, Switzerland) with exposure settings of 40 kv, 12.5 mAs, and 18.9 ms, a Multix table (no grid) (Siemens, Switzerland), an imaging plate of 35.4 x 43.0 cm, DI-AT film (dry, 35 x 43 cm) (Fuji, Switzerland), a digital FCR AC-3CS reader (Fuji, Switzerland), and a FM-DP 3543 printer (Fuji, Switzerland). Animals were held on the table with the forelimbs extended cranially and the hindlimbs caudally, and exposure was performed during full inspiration whenever possible (Fig. 1, Fig. 2).

Data collected from the medical records reported the breed, age, gender, and type of trauma, if the case was a referral from a private practitioner and was presented by the owner, any further diagnostic imaging performed, whether surgical or conservative treatment was later undertaken, and the clinical outcome. All radiographs were examined by the first author and an ECDVI diplomate.

The incidence of the individual data parameters was evaluated. The radiographic diagnoses were grouped by affected body region into thoracic, abdominal, pelvic, spinal, or peripheral soft tissue injuries. The latter included signs of injury to the skin, subcutis, fascia and muscles. The correlation between the individual parameters and outcome was evaluated by univariate analysis using statistical software (StatView 5.1, SAS Inc., Switzerland). Linear data were analyzed using simple regression. The correlation between linear and categorized parameters was investigated using univariate analysis of variance (ANOVA) assuming a standard error. Data found to be statistically significant were subsequently analyzed using a Bonferroni Test. The correlation between different categorized data was analyzed with a Chi^2 test. Fishers exact test was used also when less than five datasets were available. Significance was set at $P \leq 0.05$ throughout.

Results

Of the 100 cats, there were 96 European shorthair cats, two Persians, one Siamese and one Birman. The average age was 2.8 years old (range 3 months to 12 years). Twenty-nine were intact females, 25 were neutered males, 23 were spayed females, and 14 were intact males. The gender remained unrecorded in nine cats.

Eighty-six cats were presented by their owners, and 16 cats by their finders. Private practitioners referred 29 of the 100 cats. The anamnesis revealed a type of trauma unknown in 32 cases, a road traffic accident in 30 cases, a fall from a height of between 6 and 27 meters from a window or balcony in 25 cases, bite wounds in seven cases, of which four were sustained from dogs and three from other cats, blunt trauma from a horse kick, a wooden clog, a stone or a collapsed iron fence in four cases, a penetrating injury from a fall onto a garden fence from a tree in one case, and a gunshot wound in one case.

Radiographic findings consistent with traumatic injury were observed in 96 of 100 cases. Injuries were located in the thorax in 53 cases (Table 1), in the abdomen in 39 cases (Table 2), on the pelvis in 34 cases (Table 3), in the soft tissues in 28 cases (Table 4), and on the spine in 26 cases (Table 5). In addition, fractures of the femur were observed in 14 cats and fractures of the scapula were observed in 3 cats. Hypovolemia, based on the size of the cardiac silhouette, the caudal vena cava and the pulmonary vasculature, was detected in 19 cats.

Additional diagnostic imaging was performed on 28 cats. Radiographs were performed in 25 cats, comprising five pelvic, five head, eight forelimb, and fourteen hindpaw images. Myelography was carried out in one case. Ultrasonography was accomplished later in 7 cases, consisting in examinations of the abdomen in five cases, the eye in one case, and the soft tissues of the proximal hindlimb in one case. Computed tomography was performed on one cranium, and on one spinal column.

Treatment included surgical intervention in 51 cats and conservative management in 28 cats. Twenty-three cats were euthanized and four died during hospitalization. The cause of death was abdominal hemorrhage in one case, peritonitis in one case, and head trauma in two cases. In total, 73 cats survived and were discharged from hospital.

A significant correlation was found between euthanasia and spinal injury (P=0.0468), in particular lumbar spinal injury (P=0.0182), abdominal injury (P=0.0500), soft tissue injury (P=0.0175), and age (P=0.0059). The most common reason for euthanasia was spinal injury. Cats were more likely not to survive with intraperitoneal free air (P=0.0186), abdominal trauma (P=0.0439), soft tissue injury (P=0.0288) or advanced age (P=0.0358).

Discussion

The average age of cats presented in veterinary practice is 7.2 years old (4). Cats presented for trauma have previously been found to be much younger, with average ages reported to be 1.3 years old (5) and 1.8 years old (6). Patients in this study were also young on average (2.8 years), corroborating present findings. Older cats were assumed at a lower risk of being involved in road accidents and other trauma with a more sedentary lifestyle and greater experience (4). Increased age was found to be a negative prognostic factor in the present study. Decreased willingness of owners to invest in the treatment of older cats, particularly those already affected by other chronic disorders could be a factor.

Only 43% of cats in the present study were male contrasting with other studies (5-8). Female cats were found to be at greater risk of high-rise syndrome in one report (5). Seventeen of 25 cats suffering from high-rise syndrome were female in this study.

Two previous researches have reported the incidence of various causes of trauma in cats (5, 9). The most frequent cause of trauma was unknown in the present study with outdoor cats returned home or were found outside with unspected injuries. An approximately equal numbers of cats suffered trauma resulting from a road traffic accident, and slightly fewer due to high-rise syndrome. Both of these were reported less frequently in previous studies (5, 9). This could be due to disparate living conditions, including differences in road traffic densities and urbanization.

Evidence of thoracic injury was found in 53% of cases as the most frequent radiographic finding in the present study. Reported incidence of thoracic injury in feline trauma patients varies between 11% and 90%. Chest radiographs were systematically performed in only two previous studies, in which thoracic injury was observed in 90% of

cats with high-rise syndrome (10) and in 39% of cats presented with fractures (6). Further studies in which radiographs were not systematically performed reported an incidence of thoracic injuries of only 11% and 23% (5, 11). Radiographic evidence of 40% of cats with chest trauma do not have clinical signs suggestive of thoracic injury (6). Chest radiographs have also been the most sensitive indicator of thoracic trauma in dogs (12). These findings suggest that chest radiographs should be considered in the work-up of trauma patients regardless of the clinical signs. Chest injury was not a significant negative prognostic indicator based on the present study.

Radiographic evidence of abdominal injury was observed in 39% of cases, the second most frequently affected region in the present study. Two previous studies reported lesser incidence of 9.7% (5) and 6.8% (10). Radiographs of the abdomen then were not systematically undertaken in all trauma patients. Cats suffering acute abdominal trauma are often found to lack clinical signs, and, as for chest injuries, radiographs seem more sensitive than the physical examination.

Loss of abdominal radiographic detail was observed in 16 cats in this study, interpreted as intraperitoneal hemorrhage or uroperitoneum. Trauma was found to be the most frequent cause (84.6%) of uroperitoneum in cats in a published study before (13). With eight cases in which the urinary bladder was not identified on radiographs, uroperitoneum was considered likely in a total of 20 cats in this study. Survey radiographs may suggest urinary tract injury, but are rarely diagnostic (14). Eight cats were euthanized due to polytrauma of the 20 suspected cases, two cats were further evaluated using abdominal ultrasound, and 10 cats were closely monitored, including physical examination, ability to void urine, and routine blood chemistries. Uroperitoneum was not diagnosed in any of the surviving cats.

Loss of retroperitoneal radiographic detail was observed in 12 cats. Of these, five cats were euthanized due to polytrauma, one cat was further evaluated using ultrasound, and six cats were monitored, including physical examination, ability to void urine, and routine blood chemistries. Ureteral and/or renal tear was not diagnosed in any of the surviving cats. The loss of radiographic abdominal and retroperitoneal detail in those animals was more likely due to hemorrhage than to significant urinary tract rupture.

Radiographic signs of abdominal injury were positively correlated to euthanasia. However, the reason for euthanasia was not only related to the abdominal injury itself but attributed to a poor prognosis related to injury of other body regions such as spinal injuries.

The whole-body radiographs were exposed such that the entire pelvic region was included in the images. Supplemental pelvic images were necessary in 5% of cases, representing 15% of animals in which pelvic injury was detected. An incidence of pelvic injury of 16% of cases due to all types of trauma (5), with 27% of cats due to road traffic accidents (4), and 8% of cats due to high-rise syndrome in cats (8) has been reported. The 34% found here could be higher because radiographs were not systematically performed in previous studies. The type of pelvic injury observed in the present study was quite varied and frequently was not an indication for surgical intervention or a poor prognostic indicator.

The peripheral soft tissues were classified as a distinct body region in this study. Radiographic evidence of injury to this region included increased soft-tissue opacity and accumulation of air. Such findings indicate the body area directly affected by the forces of trauma. The location of soft tissue injury, observed here in 28 cases, suggests that cats most frequently sustain trauma to an area caudal to the diaphragm. Soft tissue injury was positively correlated to euthanasia in this study, and most euthanized cats were found to have signs of injury to various other body regions.

The whole-body radiographs provided images of the spine from the first thoracic to the middle of the coccygeal vertebrae. Signs of trauma to this area were observed in 26% of cats in this study. It included 13 lumbar or sacral vertebral body fractures, 10 injuries to the coccygeal or sacrococcygeal region and three fractures of a spinous or transverse process in the lumbar or sacral spine. Sacrococcygeal dislocation was observed only in cats involved in a road traffic accident or following trauma of unknown cause. Previous studies have reported spinal lesions in only 2% of cats suffering from high-rise syndrome (8, 10). Radiographic evidence of spinal injury was observed in 24% of the 25 cats affected by high-rise syndrome in the present study. This may result from a different case load or that not all injuries were clinically suspected and radiographs were not systematically performed in previous studies. Survey radiographs have been recommended prior to additional manipulation of the animal, when vertebral injury is

clinically suspected (15). In such cases, a laterolateral image is generally evaluated before the cat is placed in dorsal recumbency for the ventrodorsal images. The high incidence of spinal trauma found in cats with high-rise syndrome in the present study suggests that judicious manipulation prior to radiographs may be warranted even when clinical suspicion of spinal injury is lacking. Cats with spinal injury were more frequently euthanized than cats with injuries to any other body region in the present study.The reason for euthanasia in these patients was generally due to the poor prognosis relating to the spinal injury.

Thoracic radiographs provide insight into circulatory filling. Hypovolemia can be confirmed when the size of the cardiac silhouette, caudal vena cava and pulmonary vessels is decreased. The whole-body images taken in the present study provided evidence of hypovolemia in 19 cats, in addition to information relating to traumatic injury.

In the present study, 51% cats were deemed to require surgical management. This is slightly higher than the previously reported 30% of cats with high-rise syndrome in one study (10), or 47% of cats involved in a road traffic accident (11).

Twenty-three percent of patients in this study were euthanized. This was higher than previous studies, reporting euthanasia in 17% of all cats involved in trauma (5), 5% of cats involved in road traffic accidents (11) and 7.1% of cats affected by high-rise syndrome (8). However, a direct comparison with previous studies is difficult due to disparate study designs and variation in the numbers of animals that were seen as first opinion cases. The numbers of animals that may have recovered if owners had not elected euthanasia is unclear. There was no significant correlation between euthanasia and whether the owner or a finder presented the cat.

The survival rate of trauma in cats in the present study was 73%. Comparison with other studies is not straightforward due to contrasting study designs. Survival was 73% in a report investigating cats involved in road traffic accidents, but cats dead on arrival were included in that report (11). Ninety percent survival rate was reported in another study of high-rise syndrome in cats (10), but cats euthanized at the request of the owners were discounted. A higher survival rate for cats suffering high-rise syndrome was corroborated in the present study in which 84% of high-rise syndrome cats survived compared to 68% of cats affected by other trauma.

The four cats in the present study that died during hospitalization were presented in a very poor general condition. Two cats suffering head trauma became comatose and died within hours of presentation. Mortality rates reported previously were higher with 27% of cats in road traffic (10), 10% of cats affected by high-rise syndrome (11), and 7% of cats involved in trauma regardless of cause (5).

Whole-body radiographs in cats, although not optimally focused and exposed for both the thorax and abdomen, are of sufficient quality and offer the prompt advantage of detecting trauma-associated abnormalities that are not suspected based on clinical signs and would otherwise be underdiagnosed if images of only the chest or the abdomen had been performed. Time during which the patient is held on a radiographic table, patient stress, cost and exposure of personnel to x-rays are also reduced.

Conclusion

The use of whole-body radiographs in traumatized cats offers a rapid and adequate overview of the thorax, abdomen, pelvis, spine and soft tissues. This is an ideal complement to the physical examination, diagnosing injuries that would otherwise not be detected, alerting the clinician to problems that may require further evaluation or observation. Only 4% of cats suffering trauma do not have any radiographic injuries at presentation. Advanced age, abdominal trauma, spinal injury and soft tissue injury were found to be negative prognostic factors relating to survival.

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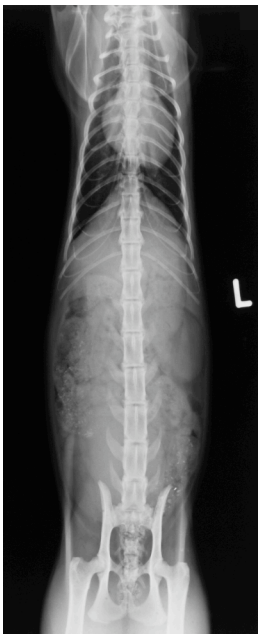
Figure 1: Whole-body radiographic image in the cat. a) The patient is supported with a foam for the ventrodorsal exposure. b) A sacral and coccygeal fracture with associated peripheral soft tissue swelling is evidenced on the laterolateral view.

a)



b)

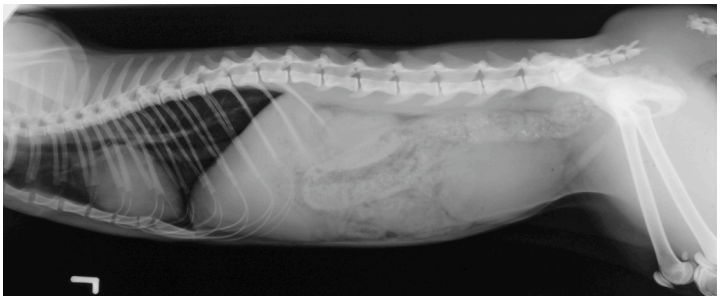


Table 1: Thoracic injuries detected by whole-body radiographs in 53 of 100 cats

Radiographic findings	Unilateral	Bilateral	Total
Lung contusion	-	-	26
Pneumothorax	5	19	24
Pleural effusion	2	12	14
Rib fracture	7	4	11
Diaphragmatic hernia	-	-	7
Traumatic bullae	-	-	7
Mediastinal effusion	-	-	4
Pneumomediastinum	-	-	2

Table 2: Abdominal injuries detected by whole-body radiographs in 39 of 100 cats

Radiographic findings	Total
Loss of intraperitoneal detail	16
Loss of retroperitoneal detail	12
Abdominal hernia	8
Urinary bladder not identified	8
Intraperitoneal free air	3

Table 3: Pelvic injuries detected by whole-body radiographs in 34 of 100 cats

Radiographic findings	Unilateral	Bilateral	Total
Sacroiliac dislocation	17	7	24
Pubic fracture	18	5	23
Ilial fracture	13	0	13
Ischial fracture	9	1	10
Pubic-symphysis diastasis	9	-	9
Acetabular fracture	7	1	8
Hip luxation	5	0	5

Table 4: Soft tissue injuries detected by whole-body radiographs in 28 of 100 cats

Radiographic findings	Cranial to the diaphragm	Caudal to the diaphragm	Cranial and caudal to the diaphragm	Total
Soft tissue swelling	3	14	1	18
Subcutaneous emphysema	8	8	2	18

Table 5: Spinal injuries detected by whole-body radiographs in 26 of 100 cats

Localization	Fracture	Luxation	Total
Thoracic	0	0	0
Lumbar	9	0	9
Sacral	7	0	7
Coccygeal	2	8	10